How the universe works: two recent books

by Carol White

Chaos—Making a New Science
by James Gleick
Viking Press, New York, 1987
$19.95, 352 pages hardbound.

Revolutions in Science
by I. Bernard Cohen
Harvard University Press, Cambridge, 1987
$25.00, 711 pages hardbound.

Chaos is in many ways a wrong-headed book, but all the same, it is extremely interesting. It describes the gradual emergence of what claims to be a new discipline: the study of how to model nonlinear systems. The "chaos" of the book's title turns out to be imaginary, as computer modeling reveals the underlying geometries of apparently random systems.

So far so good! The problem is that Gleick—and he tells us that he represents the opinion also of the people in the field whom he cites—treats nonlinearity as essentially non-directional. What appears random at one level, may well have structure when it is viewed in greater detail, but this does not imply the potential for perfectibility, at every level of God's universe.

Chaos theory emphasizes how the microcosm can act to transform the macrocosm, so that apparently small differences on the microlevel have major consequences. This is by no means a new insight: See, for example, Gottfried Leibniz's *Monadology*. But Leibniz recognized these least-action quanta as the point of intervention for the continued evolution of the universe; he saw creation as a continuous process.

This essential flaw is reflected in the acausal approach to modeling, reported in the book. It is not process which is modeled, but its footprints as revealed in the structure of apparently random collections of particles. The ability, nonetheless, to extract intimations of a tendency to an ordering principle, owes thanks to the developing capability of computers to repeat iterative processes.

The polemic that linear models are incapable of adequately expressing reality is useful, even if it is not the new discovery implied by Gleick. Anything which weakens the stranglehold of Newton and Maxwell's Aristotelian methodology on the sciences is welcome. Nonetheless, it is a real weakness of the book, that it fails to identify the critical discoveries of such 19th century giants in the field of nonlinear mathematical physics as Bernhard Riemann, Karl Weierstrass, and Georg Cantor.

Unlike the practitioners of "chaos" theory, their concern was to demonstrate the possibility of *intelligibly* representing apparently arbitrary functions. And even before them, Johannes Kepler recognized the crucial significance of such "modern" topics as aperiodic crystals, and the formation of snowflakes.

The great merit of this book, is that it affords a lively, popular survey of some of the current methodology being applied across disciplines, to model nonlinearity.

Kepler through the eyes of Cohen

A popular book which seeks to clarify a new field, and

thus serves as a guide and an introduction to an otherwise unfamiliar area of research—such as *Chaos*—is useful; a survey text is generally an abomination. Such is I. Bernard Cohen's pretentious claim to survey the entire history of modern science.

Cohen's ostensible subject is how scientific theory evolves. In his introduction he admits that his book is essentially a retread of T.S. Kuhn's work on the same subject, although he—Cohen—pretends to the broader viewpoint of the historian, as opposed to merely that of the historian of science.

I would contend that not only is his book useless to the serious student and boring to the casual reader, but it is purely and simply a fraud. The thread through his study is a defense of the Aristotelian methods of Isaac Newton and James Clerk Maxwell, and an attack on the Platonic school of science. To accomplish his purpose he retails a bunch of tired lies.

Since Cohen is a prestigious as well as a prodigious writer in his field, I shall substantiate my contention at some length with regard to his treatment of the father of modern mathematical physics, Johannes Kepler. Thus Cohen writes of Kepler:

"And yet he was a true believer in astrology (the last major astronomer, in fact, to be in any degree a convinced astrologer), his scientific thought is suffused with what has been called number mysticism, and he argued from first principles of cosmological necessity. He was particularly proud of his early 'discovery' of a direct relationship between the number, size, and arrangement of the planetary orbits and the existence of five (and only five) regular geometric solids."

Before taking on Cohen's scurrilous attack on Kepler, it is to the point to note that he appears to conveniently overlook the well-documented predilection of Isaac Newton for occultism.

Indeed, Newton devoted the majority of his energy, during that period of his life when he was a practicing scientist, both to the study of alchemy and to numerological calculations based upon biblical texts, of when the end of the world is to be expected. He was also interested in medical remedies such as the following, communicated to him by his friend John Locke: To cure a kidney ailment bury the patient's urine in the garden overnight. This cure was supposed to work even if the patient was not aware that it was being undertaken on his or her behalf!

It is true that part of Kepler's job as court astronomer to the Hapsburgs, was to prepare astrological predictions, but these may better be compared to Benjamin Franklin's *Poor Richard's Almanack* than the Sunday supplement. Kepler used the medium of prediction to urge a peaceful solution to the impending Thirty Years' War, in terms which were only

FIGURE 1
The golden mean and the pentagon

a) $\Phi = 1.618...$ where Φ represents the golden mean.

$\Phi/1 = 1/\Phi^2$ $\quad \Phi^2 - \Phi = 0$ $\quad \Phi = \frac{\sqrt{5}+1}{2}$

b) Regular pentagon

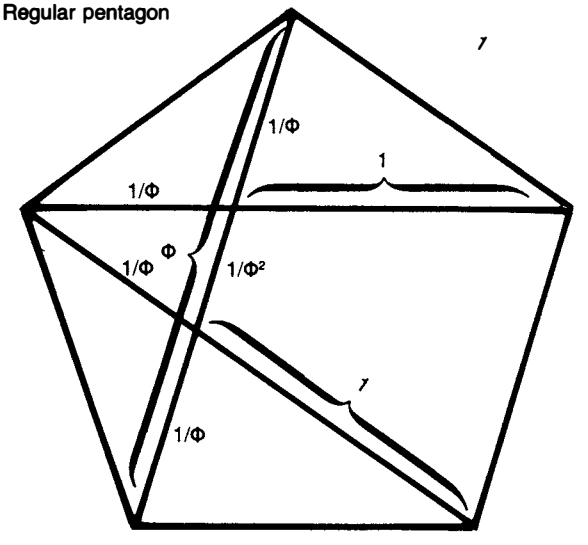
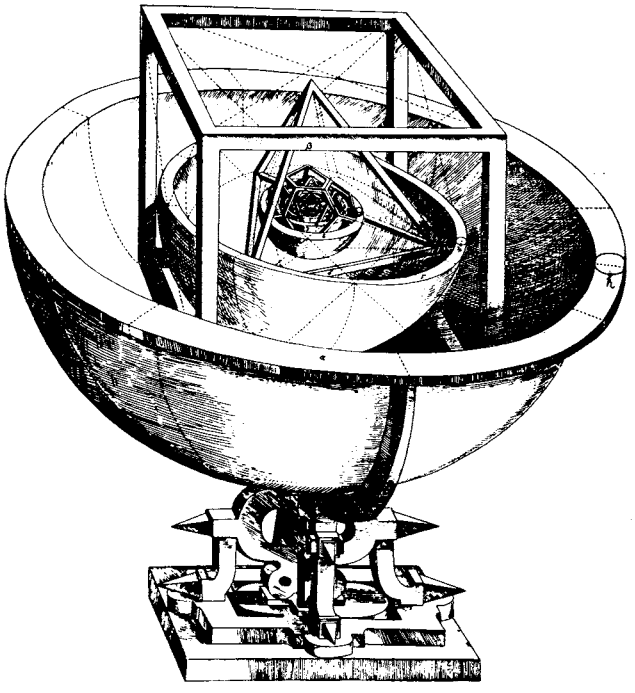


FIGURE 2
The Kepler models



thinly veiled. He did not overrule that the confluence of radiant energy emitted by the stars might influence meteorology, but he certainly did not subscribe to the bestial notion that man's fate is determined by astral influences.

Was it a revolution?

Cohen admits that it was Kepler rather than Copernicus who transformed astronomy. He even quotes J.L. E. Dreyer, an historian of science who wrote at the turn of this century, that it was Kepler and not Copernicus to whom scientists of the 17th century and afterward referred, when they discussed the Copernican system (*A History of Astronomy from Thales to Kepler*).

Yet Cohen dismisses Kepler's importance because scientists were slow to recognize the implications of his work. For Cohen, it was Newton rather than Kepler who achieved a revolution in physical astronomy. Perhaps this might devolve upon the use of the term "revolution." Should a scientist aspire to create a revolution, or to understand and teach truth? In our "other-directed" society, to use David Riesman's term, such a question does not appear to suggest itself to Cohen.

Indeed Cohen is so eager to dismiss the implications of Kepler's work—still not to this day fully appreciated by "mainstream" physicists—that he casts scorn on Kepler's largely successful, if incomplete, hypotheses about how the solar system was created. Kepler, unlike Newton and far too many scientists today, was unwilling to accept a model solely on the pragmatic argument: "It works." Newton, of course, cheerfully accepted that arbitrary initial conditions accounted for the distance of the planets from the Sun, just as he was willing to use the subterfuge of instantaneous action-at-a-distance to account for the propagation of gravitational force.

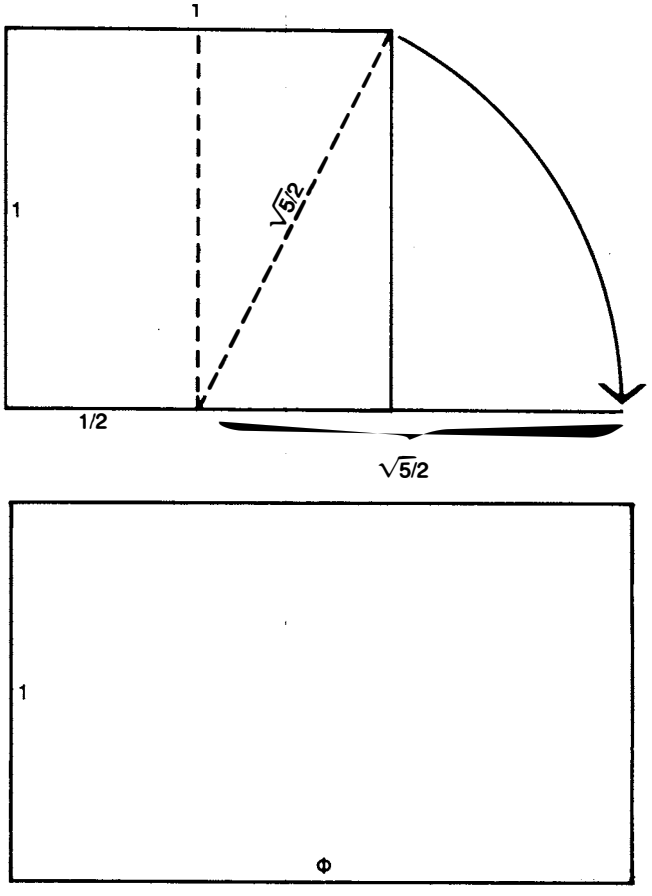
The distance of the planets from the Sun

Kepler hypothesized that the creation of planets must be governed by principles similar to those which underlie the growth of living forms—in other words, the geometry of the golden mean. In this he based himself upon the insights of Leonardo da Vinci and his collaborator, Luca Pacioli. (The golden mean, also known as the golden section or the divine proportion, divides a line so that the ratio of the length of the line to its largest segment is proportional to the ratio of the segments to each other.) This ratio governs the construction of the pentagon (see **Figure 1,** showing the ratio between the side and diagonal of the pentagon and the segments of the diagonals as they intersect), which features in Kepler's model as the face of the dodecahedron.

Kepler's model (**Figure 2**) accounted for the distances of the planets from Saturn to Mercury as determined by an embedded sequence of the five regular, Platonic solids. According to this model, Saturn was separated from Jupiter by the dimensions of a cube; Jupiter from Mars by a tetrahedron; Mars from Earth by a dodecahedron; Earth from Venus by an icosahedron; and Venus from Mercury by an octahedron. Readers will recall that Dr. Robert Moon's model for the internal structure of the atom (see *EIR* No. 43, Oct. 30, 1987, and No. 44, Nov. 6, 1987) is very similar to this. Moon requires another cube inscribed inside of the octahedron, and

How the golden mean governs the geometry of growth

FIGURE 3a



Construction of a golden mean rectangle.

it begins with the dodecahedron—eliminating the tetrahedron and the bounding outer cube.

Both models capture the golden-mean geometry as a predicate of the solid figures (cf. **Figure 3**); however, recently Jonathan Tennenbaum has noted that the placement of the planets can be closely modeled to two rotations of a logarithmic spiral—with the added feature that the planets are positioned according to a division of the spiral into 12 equal angular rotations.

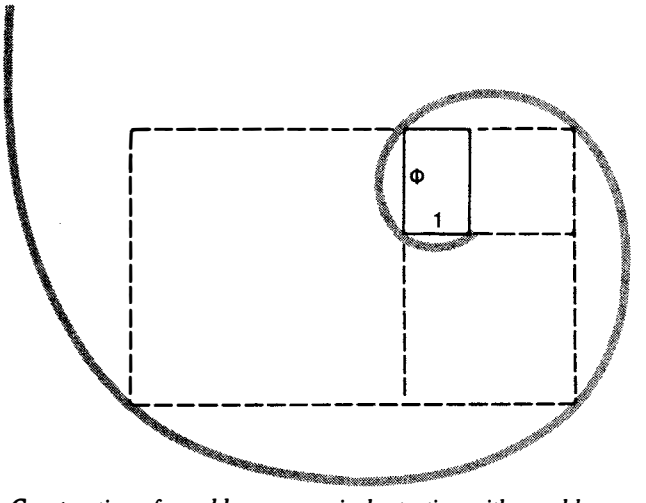
Kepler anticipated the discovery of the asteroid belt, not-

Because of the golden mean's property of double self-similarity, two segments in the golden mean ratio can be lengthened by combining them and adding on the amount of the larger segment, so that the new length is also divided by the golden mean. Replicating this same process of construction will produce a series which rapidly converges on the golden mean ratio, $(1 + \sqrt{5})/2$.

The Fibonacci series approximates the growth of a population because only that part of the population which is sexually mature is capable of reproducing itself, while the other portion, the young, is being nurtured as a potential for the future.

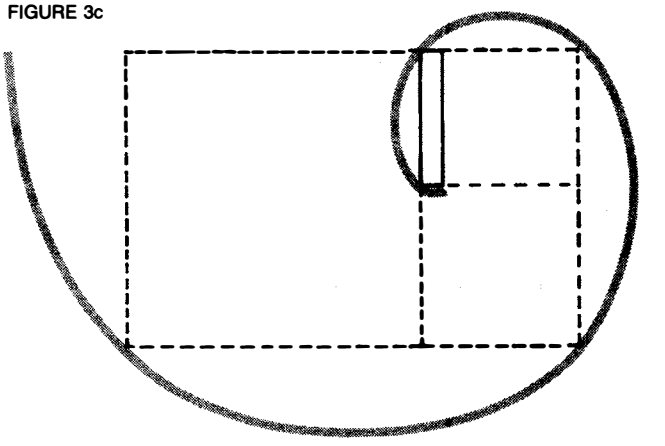
A logarithmic spiral grows proportionally as it rotates. Every logarithmic spiral can be constructed by the same method as the golden mean spiral, although its rate of growth will differ. For example, consider a population in which the sexually mature segment of the population does not double itself in each time period, but merely grows at the rate of 50%. It will converge to the ratio value of 1.36606. . .

FIGURE 3b



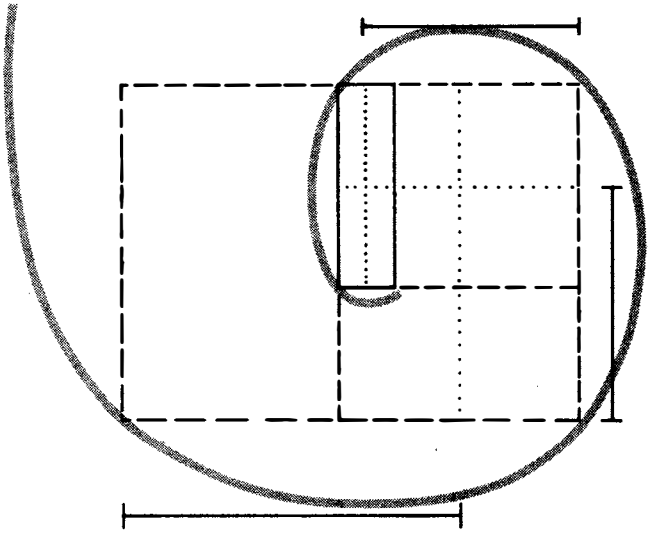
Construction of a golden mean spiral, starting with a golden rectangle. This spiral is a logarithmic spiral whose radius has grown by the ratio Φ every time it has completed a 90° rotation.

FIGURE 3c



Using the same method of construction but beginning with any arbitrary rectangle, we can approximate a golden mean spiral.

FIGURE 3d



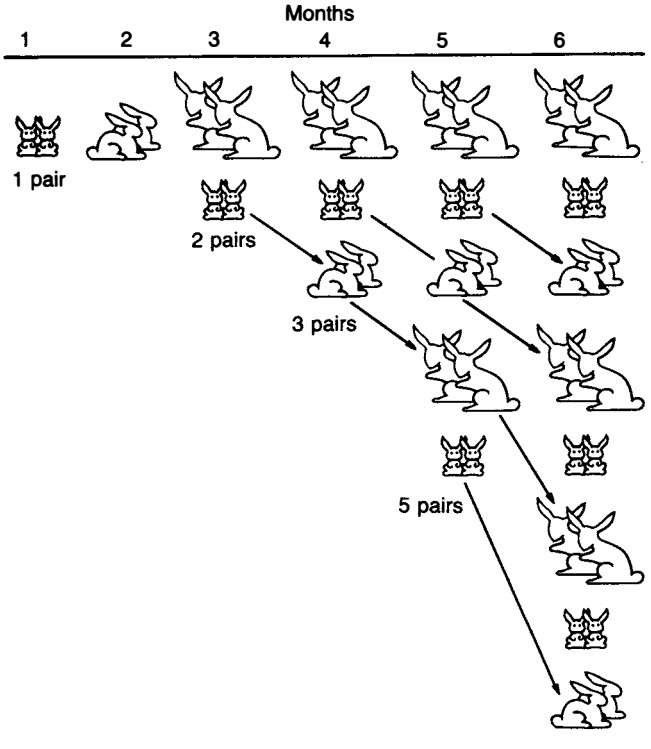
Construction of a logarithmic spiral which grows in the ratio of approximately 1.4 every 90°, using the same method as above, but adding a square of the long side at the midpoint of the short side.

ing that the distances of the planets from the Sun could be approximated by a spiral. He believed that his Platonic model was superior, because he reasoned that the known planets agreed topologically with the fact that only five symmetrical solids can be built in three-dimensional space.

At the beginning of the 19th century, two astronomers, Titius and Bode, predicted the discovery of the asteroid belt as a by-product of the so-called Titius-Bode law. The law states that if we normalize the distances to the Earth's distance from the Sun—and give that the value 10—then Mercury has the distance 4, Venus 7, Mars that of 16, and so on. (The formula is $4 + 3 \times 2^n$.) Both the values as determined by the Titius-Bode law and by Kepler's geometric model are still considered to be accurate today.

Cohen does not even trouble himself to describe Kepler's other, marvelous discovery: that the angular velocities of the planets at their maximum and minimum distances from the Sun are related to each other in the same ratios as the musical intervals on the scale. Kepler noted that the eccentricities of the planets' elliptical orbits are determined according to these harmonic resonances, so that neighboring planets will be in the same ratios to each other as consonant intervals on the scale (the fourth, the fifth, the minor and major third, and the sixth) (see **Tables 1** and **2**).

FIGURE 4
The Fibonacci rabbits



It takes two months for a pair of rabbits to become sexually mature. Each month thereafter, they reproduce one pair of rabbits.

Newton's revolution

In contrast to his treatment of Kepler, Cohen's praise of Newton is extravagant. Let's see what he has to say.

"From a historical vantage point," writes Cohen, "Newton was an extraordinary figure because he made so many fundamental contributions to different fields: pure and applied mathematics; optics and the theory of light and colors; design of scientific instruments; codification of dynamics and formulation of the basic concepts of this subject; invention of the primary concept of physical science (mass); invention of the concept and law of universal gravity and its elaboration into a new system of the universe; invention of the gravitational theory of tides; and formulation of the new methodology of science. He also worked on heat, the chemistry and theory of matter, alchemy, chronology, interpretation of Scripture, and other topics" (page 161).

Although alchemy, chronology, etc. are given mention, these apparently only serve to add to Cohen's esteem. As we shall see below, these claims on behalf of Newton can be directly refuted by Kepler's published work. In order to underscore the dishonesty of Cohen's claims on behalf of Newton, I wish to submit one further quotation from Cohen's book.

On page 169, he writes: "The [i.e., Newton's] law of universal gravitation explains why the planets follow Kepler's laws approximately and why they depart from the laws in the way they do. It was the law of universal gravitation which demonstrated why (in the absence of friction) all bodies fall at the same rate at any given place on the earth and why the rate varies with elevation and latitude. The law of gravitation also explains the regular and irregular motions of the moon, provides a physical basis for understanding and predicting tidal phenomena. . . ."

In the section which follows, I shall quote from the English-language edition of Kepler's *Dream*. Surely Cohen cannot claim ignorance of this work! The truth is that it is individuals such as Cohen, the Victor S. Thomas Professor of the History of Science, Emeritus, of Harvard University, who deliberately distort and suppress the true history of science, and seek to impose their interpretation on any who wish to write on the subject.

In this they are merely carrying on the tradition of Newton himself, who branded Gottfried Leibniz a plagiarist for his discovery of the calculus, appropriated Robert Hooke's discovery of the application of the inverse square law to the law of gravity, and confiscated the star charts of the Royal Astronomer John Flamsteed, because of a disagreement between them. I would not like to speculate on Cohen's motives, but he has allied himself to that political tendency which has always been the enemy of progress, and denied the potential for perfectibility of mankind.

TABLE 1
Kepler's musical system

Planet	Daily journey	Ratio	Assumed musical frequency	Musical frequency value
The inner planets				
Mars				
Ap.	26.19	.2722	185.8	F♯ — G
Per.	38.09	.3959	270.4	C♯
Earth				
Ap.	57.18	.5944	406	A♭
Per.	61.14	.6356	434	A
Venus				
Ap.	94.90	1	341.3	F
Per.	97.53			
Mercury				
Ap.	165.07	1.715	293	D—E♭
Per.	380.01	3.95	337.2	F
Sun	874.2	9.087	387	G
The outer planets				
Pluto				
Ap.	.148	.0327	267	C♯
Per.	.408	.0901	368.9	F♯
Neptune				
Ap.	.352	.0777	318	E
Per.	.364	.0803	329	E—F
Uranus				
Ap.	.642	.1417	290.2	D
Per.	.772	.1704	349	F—F♯
Saturn				
Ap.	1.80	.3974	406.9	A♭
Per.	2.24	.4945	258.9	C
Jupiter				
Ap.	4.53	1	256	C
Per.	5.50	1.1198	311	E♭

The planets are given assumed note values on the musical scale, according to the modern equal tempered system, for ease of comparison of the ratio values of their angular velocities and musical intervals. Note the occurrence of the asteroid belt is chosen as the register shift in analogy to the soprano register shift at F-sharp, when Middle C is tuned to 256 cycles/second. Aphelion refers to the maximum distance of the planet from the Sun and perihelion to the minimum distance. At the boundaries of the register shifts such as Mercury's near distance to the Sun and the asteroid belt, the musical values are seen to be disturbed, thus proving the point by exception. Venus is taken as the base value for calculating the ratios for the inner planets since it has a nearly circular orbit. Jupiter is chosen for the outer orbits.
The Sun rotates once every 24.7 days. It rotates 14.57 degrees per day.

Setting the record straight

Kepler's *Dream* was written in 1606, fifty years before Newton wrote the *Principia*. The book was circulated widely, in draft, during Kepler's lifetime, but was only published posthumously by his son, Ludwig, in 1634. In it, Kepler relates the account of a fictional journey to the Moon.

Kepler is honored for having first discovered the real nature of the orbits traveled by the planets, but his actual work is by-and-large overlooked. This is a double loss: Not only is his work of great beauty, as all true science is, but also his method is the only one capable of generating great discoveries. This method is completely obscured today, however, because the figure of Isaac Newton is wrongly made to overshadow that of Kepler. Setting the record straight is no mere empty exercise in historical justice; it is critical if there are to be more Keplers to follow in his footsteps.

It is falsely taught that Kepler, in his famous Three Laws, described the orbits of the planets but did not understand the role of mass in determining the gravitational force, nor did he supposedly understand that the Moon and bodies falling to Earth all operated by the same principles. That this is not so is shown in the quotations below. Kepler perfectly understood that bodies responded to a gravitational field differently, according to their mass, and he comprehended the attraction between objects; however, he sought to understand far more. He demanded to understand *why* they were created as they were.

Cohen to the contrary, 50 years before Newton, Kepler had already described the nature of gravity and the fact that it operated in heaven and on Earth in the same manner. He not only recognized that the laws governing the orbit of the Moon around the Earth are identical to those governing the revolution of the planets around the Sun, but he explicitly noted that the Moon would be subject to the gravitational fields of both the Earth and the Sun, and he described the action of the tides in terms of the Moon's pull upon the waters of Earth. Kepler amended and added to the *Dream* throughout his lifetime, and some of the most important material appears in his footnotes to the body of the story.

The *Dream* by Johannes Kepler is translated from the Latin by Edward Rosen in an edition published by the University of Wisconsin Press (Madison, Milwaukee, and London, 1967). In footnote 62 of the *Dream*, (pages 69 and 70) Kepler noted in part: "When the Moon is located directly above the Atlantic Ocean, the so-called Southern Ocean, the Eastern Ocean, or the Indian Ocean, it attracts the waters

TABLE 2

Approximate frequency values of the equal tempered scale

C	256
C♯	271.2
D	287.3
D♯	304.4
E	322.5
F	341.3
F♯	362
G	383.6
G♯	406.4
A	430.5
A♯	456.1
B	483.3
C′	512

clinging to the sphere of the Earth. The effect of this attraction is that from all sides the waters rush to the huge area which is directly below the Moon and is not closed off by the continents, so that the shores are exposed. But in the meantime, while the waters are in motion, the Moon moves away from its position directly above an ocean. The mass of water beating against the western shore is no longer affected by the attractive force, flows back, and in turn pounds against the eastern shore."

In footnote 66, he wrote (page 71) that he defines, " 'gravity' as a force of mutual attraction, similar to magnetic attraction. But the power of this attraction in bodies near to each other is greater than it is in bodies far away from each other. Hence they offer stronger resistance to being separated from each other when they are still close together."

In footnote 202 (page 123) we find this further elaboration by Kepler: "The causes of the ocean tides seem to be the bodies of the Sun and Moon attracting the ocean waters by a certain force similar to magnetism. Of course the body of the Earth likewise attracts its own waters, an attraction which we call 'gravity.' What, therefore, prevents us from saying that the Earth attracts the lunar waters too, just as the Moon attracts the terrestrial waters?"

In the appendix to this book, editor Rosen cites a letter by Kepler to a fellow scientist, which he wrote on the occasion of the publication of his *New Astronomy*, in 1609. This is the book in which Kepler had first advised the world about the elliptical orbit of Mars. (This letter appears in the translator's Appendix H in the *Dream*, page 221.) In it Kepler explains:

"[Gravity] is exactly the same in a big body and a small body; it is divided according to the size of the bodies, and it receives the same dimensions as the body. Suppose that a stone of a magnitude having some perceptible ratio to the size of the Earth were placed behind the Earth. Let it be the case that both are exempt from all other motions. Then I say that not only will the stone move toward the Earth, but also the Earth will move toward the stone. They will divide the intervening space in the inverse ratio of their weights. Then *C* being the place where they will meet, as *A* [the Earth] is to *B* [the stone] in size, so [the distance] *BC* will be to [the distance] *CA*, in exactly the same ratio as is utilized in a balance with unequal arms."

In the *New Astronomy*, itself Kepler had written: "Rather than the stone seeking the Earth, the Earth attracts the stone. . . . Suppose that somewhere in the universe two stones were put near each other, yet outside the sphere of the force exerted by any kindred body. Like two magnetic bodies, those stones would come together at an intermediate place. As each one approached the other the distance traversed by the other would be in proportion to the other's size."

Kepler believed in the true perfectibility of man, and for him science was the royal path to that progress. In the book in which he first wrote about the geometrical principles which governed the creation of the solar system, the book, *The Secret of the Universe*, published at Tübingen, Germany in 1596, he expressed his credo in the introductory dedication. This, by the way, is the book which Cohen deprecates as astrology and number magic. Here Kepler wrote:

"Do you require something important? Nothing is more precious, nothing more splendid than this in the brilliant temple of God. Do you wish to know something secret? Nothing in the nature of things is or has been more closely concealed. The only thing in which it does not satisfy everybody is that its usefulness is not clear to the unreflecting.

"Yet here we are concerned with the book of Nature, so greatly celebrated in sacred writings. It is in this that Paul proposes to the Gentiles that they should contemplate God like the Sun in water or in a mirror. Why then as Christians should we take any less delight in its contemplation, since it is for us with true worship to honor God, to venerate him, to wonder at him? The more rightly we understand the nature and scope of what our God has founded, the more devoted the spirit in which that is done. How many indeed are the hymns which were sung to the Creator, the true God, by the true worshipper of God, David, in which he draws arguments from the marvels of the heavens. 'The Heavens are telling,' says he, 'the glory of God. I shall see Thy heavens, the work of Thy fingers, the Moon and stars, which Thou hast created. Great is our Lord, and great is his excellence, Who numbers the multitude of the stars, and calls them by name.' "

It is ridiculous that anyone should waste his or her time reading Bernard Cohen's dishonest pontifications when Kepler's own writing is so beautiful. Albeit the section on Kepler and Newton is only a small part of this work, it is so fatally flawed that I did not consider it necessary to examine the rest of the book in detail.